

## Military COTS 3-Phase AC Line Filter

|  |                                     |   |  |  |
|--|-------------------------------------|---|--|--|
| <b>320 to 528 Vrms</b><br>(L-L) 3-Phase<br>Input Voltage | <b>10 Arms</b><br>Output<br>Current | <b>110 mΩ @ 25°C</b><br>Max Resistance<br>per Phase | <b>50dB @ 200kHz</b><br>Differential Mode<br>Noise Attenuation | <b>50dB @ 200kHz</b><br>Common Mode<br>Noise Attenuation |
|--|-------------------------------------|---|--|--|

**Full Power Operation: -55 °C to +100 °C**

## MilCOTS™



The MilCOTS 3-phase AC EMI Line Filter is an essential building block of an AC-DC power supply. Used in conjunction with SynQor's MPFC-440-3PH-400-LE 3-phase PFC module, this filter will allow compliance with key MIL-STD-461 EMI requirements, assuming proper system-level design. This filter has both high differential and common-mode attenuation, with low series resistance for low overall power dissipation. Designed and manufactured to comply with a wide range of military standards, SynQor's innovative packaging approach ensures survivability in the most hostile environments.

MACF-440-3PH-UNV-MP-D-M

### Operational Features

- -55 °C to +100 °C baseplate temperature
- 10 Arms output current
- Low series resistance
- Differential and Common-mode filtering
- Meets common EMC standards in properly designed system with SynQor's MPFC-440-3PH-400-LE 3-Phase PFC module

### Mechanical Features

- Case Size: 4.87" x 3.67" x 0.60" (124 x 93.3 x 15.3 mm)
- Total weight: 18.5 oz (525 g)

### In-Line Manufacturing Process

- AS9100 and ISO 9001 certified facility
- Full component traceability

### Compliance Features

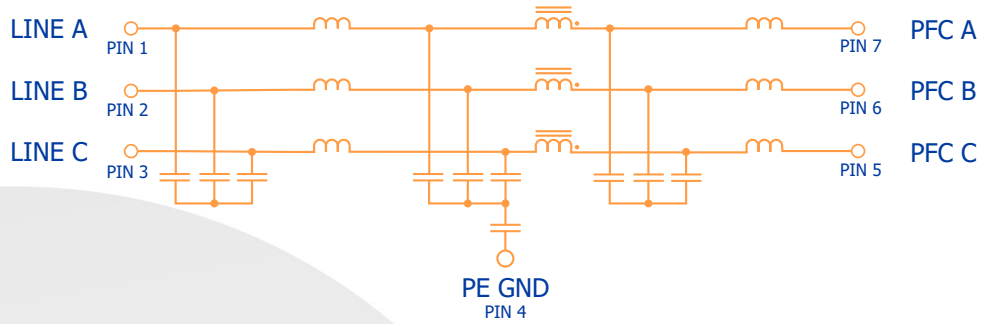
- Designed to meet (with MPFC-440-3PH-400-LE module)
- MIL-STD-1399
  - MIL-STD-461 (C, D, E, F)
  - MIL-STD-810G

### Contents

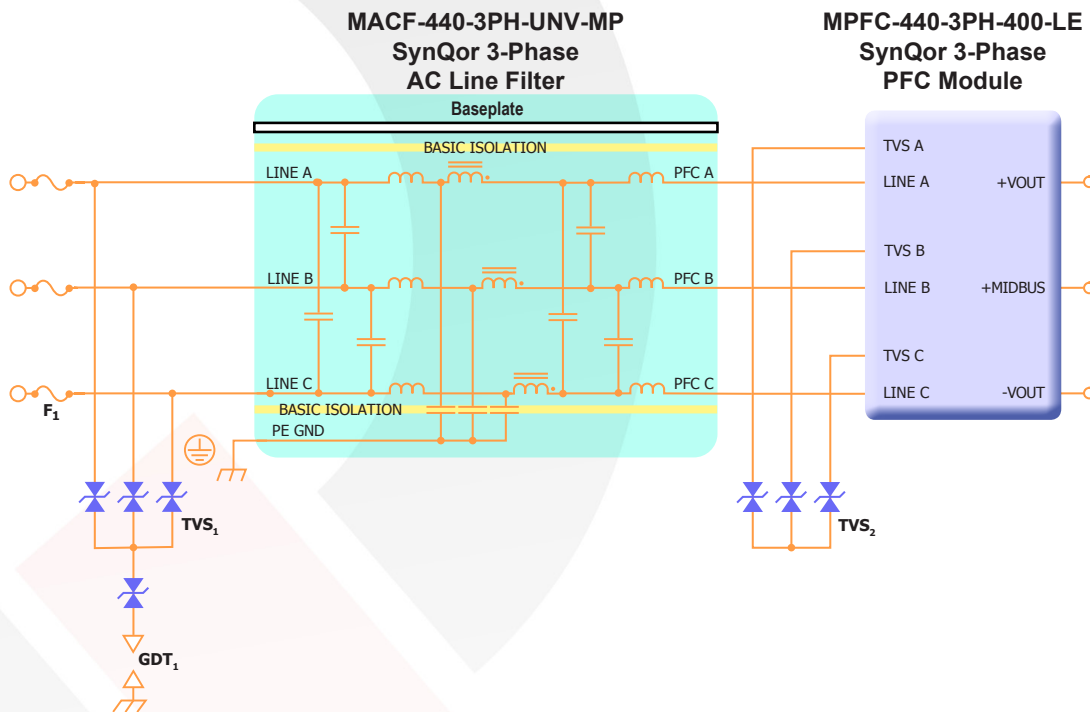
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### Technical Diagrams

#### Fundamental Circuit Diagram



#### Typical Application Diagram



#### Suggested Parts:

- $TVS_1$  : 430 Vpk, 10 kA; Littelfuse AK10-430C or Bourns PTVS10-430C-TH
- $TVS_2$  : 430 Vpk, 3 kA; Littelfuse AK3-430C or Bourns PTVS3-430C-TH
- $GDT_1$  : 1.5 kV, 3 kA; Littelfuse GTCA28-152M-R03
- $F_1$  : 500 VAC, 30 kA; Littelfuse 0505020.MXEP



**MACF-440-3PH-UNV-MP Electrical Characteristics**

Operating Conditions: Vin = 440 Vrms L-L (254 Vrms L-N) @ 60 Hz; 6.8 Arms per phase; baseplate temperature 25 °C unless otherwise noted. Full operating baseplate temperature is -55 °C to 100 °C. Specifications subject to change without notice.

| Parameter   | Min. | Typ. | Max. | Units                | Notes & Conditions                                      |
|---|------|------|------|----------------------|---|
| <b>ABSOLUTE MAXIMUM RATINGS</b>                                 |      |      |      |                      |   |
| Input Voltage   |      |      |      |                      |   |
| Operating   |      |      | 576  | Vrms L-L             | Continuous (333 Vrms L-N)                               |
| Operating Transient   |      |      | 1150 | Vpk L-L              | Voltage clamped by external TVS devices                 |
| Isolation Voltage   |      |      | 3000 | Vdc                  | Input/Output to PE GND pin & baseplate                  |
| Operating Case Temperature                                      | -55  |      | 100  | °C                   | Baseplate temperature                                   |
| Storage Case Temperature  | -65  |      | 135  | °C                   |   |
| <b>RECOMMENDED OPERATING CONDITIONS</b>                         |      |      |      |                      |   |
| Input Voltage (Continuous)                                      | 320  | 440  | 528  | Vrms L-L             | 185 to 305 Vrms L-N                                     |
| Input Frequency   | 45   |      | 800  | Hz                   |   |
| Output Current Range  |      | 6.8  | 10   | Arms                 | Per phase   |
| <b>ELECTRICAL CHARACTERISTICS</b>                               |      |      |      |                      |   |
| Series Resistance Rs  |      |      |      |                      | Per phase   |
| Tcase = 25 °C   |      | 90   | 110  | mΩ                   |   |
| Tcase = 100 °C  |      | 120  |      | mΩ                   |   |
| Total Power Dissipation   |      |      |      |                      | At 440 Vrms L-L; see note 1                             |
| Zero Load, 60 Hz  |      | 1.2  |      | W                    |   |
| Zero Load, 400 Hz   |      | 5.0  |      | W                    |   |
| 6.8 Arms (per phase) @ 60 Hz, Tcase = 25 °C                     |      | 14   |      | W                    |   |
| 6.8 Arms (per phase) @ 60 Hz, Tcase = 100 °C                    |      | 18   |      | W                    |   |
| 10 Arms (per phase) @ 400 Hz, Tcase = 25 °C                     |      | 32   |      | W                    |   |
| 10 Arms (per phase) @ 400 Hz, Tcase = 100 °C                    |      | 41   |      | W                    |   |
| Differential-Mode Line-Line Capacitance                         |      | 0.22 |      | μF                   | Value of each cap in Δ network across line; see note 1  |
| Internal Resistance (of each resistor in Δ network across line) |      | 2.0  |      | MΩ                   | Discharges internal capacitors for safe handling        |
| Reactive Power (per phase)                                      |      |      |      |                      |   |
| 60 Hz   |      | 18   |      | VAR                  | See note 1  |
| 400 Hz  |      | 120  |      | VAR                  | "   |
| Common-Mode Line-Ground Capacitance (per phase)                 |      | 10   |      | nF                   | Three such capacitors connect each line to PE GND       |
| PE GND Terminal Leakage Current                                 |      |      |      |                      | Measured with series 500 Ω per IEC 60990 Fig. 5         |
| 60 Hz, normal balanced input                                    |      | 0.36 |      | mArms                | AC input system neutral at ground                       |
| 400 Hz, normal balanced input                                   |      | 1.4  |      | mArms                | "   |
| 60 Hz, ground fault on one phase                                |      | 3.0  |      | mArms                | AC input system floating; neutral at 254 Vrms to ground |
| 400 Hz, ground fault on one phase                               |      | 16   |      | mArms                | "   |
| Differential-Mode Attenuation, 200 kHz                          |      | 50   |      | dB                   | See Figure A  |
| Common-Mode Attenuation, 200 kHz                                |      | 50   |      | dB                   | "   |
| Isolation Resistance  | 100  |      |      | MΩ                   | Any pin to PE GND                                       |
| <b>RELIABILITY CHARACTERISTICS</b>                              |      |      |      |                      |   |
| Calculated MTBF (MIL-217) MIL-HDBK-217F                         |      | 84   |      | 10 <sup>6</sup> Hrs. | Ground Benign, Tb = 70 °C                               |
| Calculated MTBF (MIL-217) MIL-HDBK-217F                         |      | 6.4  |      | 10 <sup>6</sup> Hrs. | Ground Mobile, Tb = 70 °C                               |

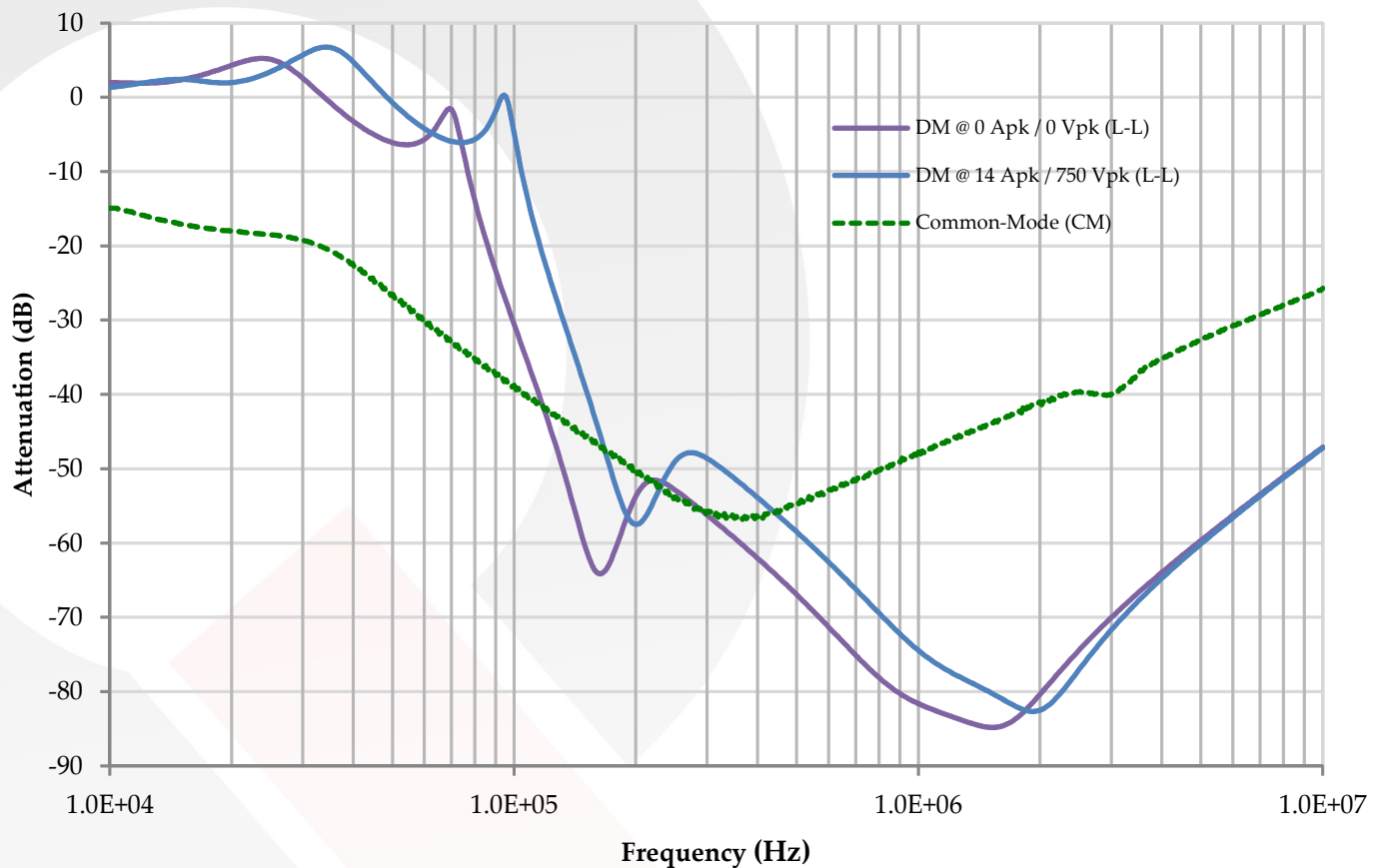
Note 1: Downstream power converter will contribute to this parameter; refer to the appropriate module datasheet.

## BASIC OPERATION AND FEATURES

This module is a multi-stage differential-mode and common-mode passive EMI filter designed to interface a 3-Phase AC power source with a SynQor MCOTS 3-Phase PFC module and one or more SynQor converters (or other loads that create EMI).

A typical application would place the MCOTS AC line filter close to the AC input power entry point. The AC line filter's PE GND pin would be connected to the chassis ground that is common with AC input power protective earth or other earthed point used for EMI measurement. The metal baseplate may be connected to the chassis ground via the metal corner mounting posts if desired.

Do not connect the inputs & outputs of multiple MCOTS 3-Phase AC line filters in parallel. Connecting filters in this manner may result in slightly imbalanced currents to flow in the three paths of each filter. These imbalanced currents will cause the internal common-mode chokes to saturate and thus degrade common-mode attenuation.



*Figure A: Typical Common-Mode (CM) and Differential-Mode (DM) attenuation as a function of frequency. DM attenuation is shown both with zero bias and at max rated peak voltage/current. Source and load resistance are 50 Ω.*

**Standards & Qualification Testing**

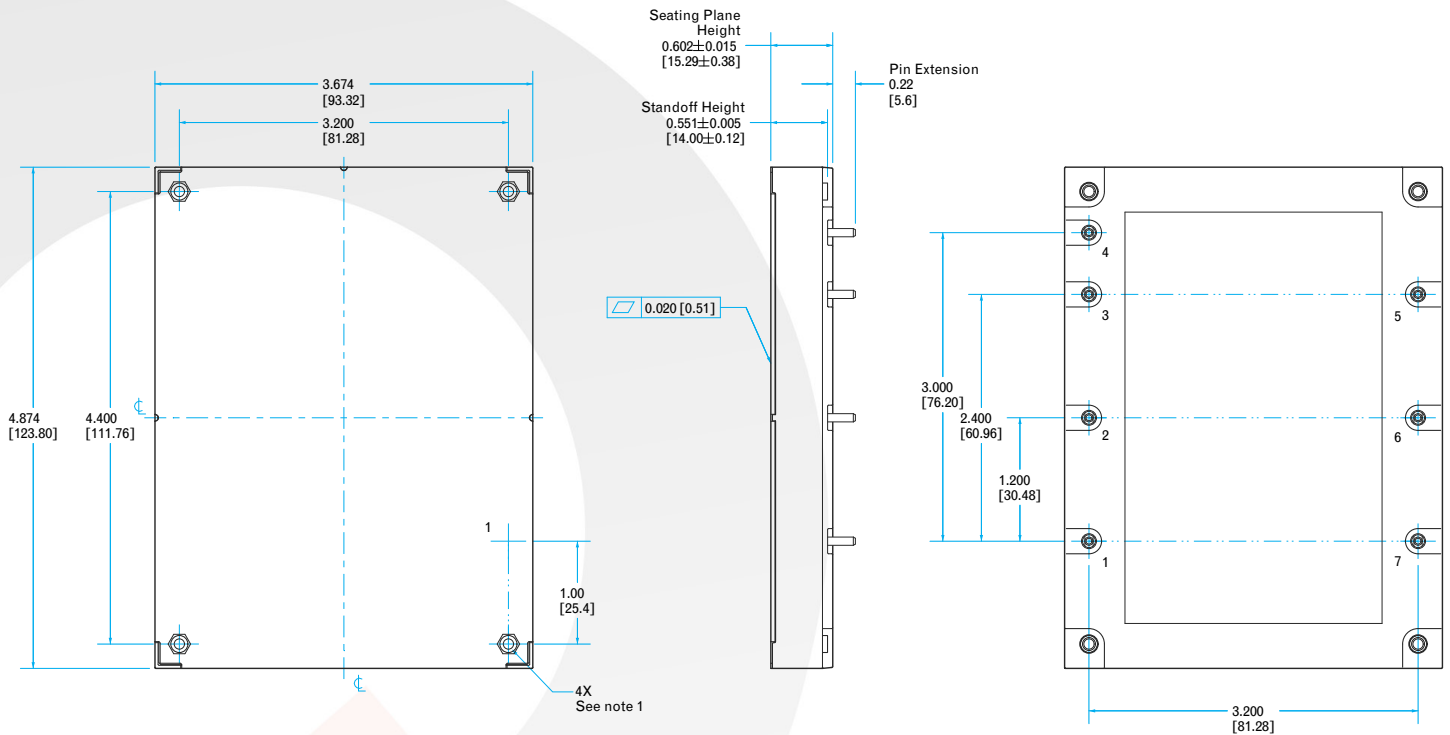
**Mil-COTS MIL-STD-810G Qualification Testing**

| MIL-STD-810G Test    | Method                  | Description  |
|----------------------|-------------------------|--|
| Fungus               | 508.6                   | Table 508.6-I  |
| Altitude             | 500.5 - Procedure I     | Storage: 70,000 ft / 2 hr duration   |
|                      | 500.5 - Procedure II    | Operating: 70,000 ft / 2 hr duration; Ambient Temperature  |
| Rapid Decompression  | 500.5 - Procedure III   | Storage: 8,000 ft to 40,000 ft   |
| Acceleration         | 513.6 - Procedure II    | Operating: 15 g  |
| Salt Fog             | 509.5                   | Storage  |
| High Temperature     | 501.5 - Procedure I     | Storage: 135 °C / 3 hrs  |
|                      | 501.5 - Procedure II    | Operating: 100 °C / 3 hrs  |
| Low Temperature      | 502.5 - Procedure I     | Storage: -65 °C / 4 hrs  |
|                      | 502.5 - Procedure II    | Operating: -55 °C / 3 hrs  |
| Temperature Shock    | 503.5 - Procedure I - C | Storage: -65 °C to 135 °C; 12 cycles   |
| Rain                 | 506.5 - Procedure I     | Wind Blown Rain  |
| Immersion            | 512.5 - Procedure I     | Non-Operating  |
| Humidity             | 507.5 - Procedure II    | Aggravated cycle @ 95% RH (Figure 507.5-7 aggravated temp - humidity cycle, 15 cycles)           |
| Random Vibration     | 514.6 - Procedure I     | 10 - 2000 Hz, PSD level of 1.5 g <sup>2</sup> /Hz (54.6 g <sub>rms</sub> ), duration = 1 hr/axis |
| Shock                | 516.6 - Procedure I     | 20 g peak, 11 ms, Functional Shock (Operating no load) (saw tooth)                               |
|                      | 516.6 - Procedure VI    | Bench Handling Shock   |
| Sinusoidal vibration | 514.6 - Category 14     | Rotary wing aircraft - helicopter, 4 hrs/axis, 20 g (sine sweep from 10 - 500 Hz)                |
| Sand and Dust        | 510.5 - Procedure I     | Blowing Dust   |
|                      | 510.5 - Procedure II    | Blowing Sand   |

**Mil-COTS Converter and Filter Screening**

| Screening                       | Process Description                               | S-Grade           | M-Grade                 |
|---------------------------------|---|-------------------|-------------------------|
| Baseplate Operating Temperature |   | -55 °C to +100 °C | -55 °C to +100 °C       |
| Storage Temperature             |   | -65 °C to +135 °C | -65 °C to +135 °C       |
| Pre-Cap Inspection              | IPC-A-610, Class III                              | •                 | •                       |
| Temperature Cycling             | MIL-STD-883F, Method 1010, Condition B, 10 Cycles |                   | •                       |
| Burn-In                         | 100 °C Baseplate                                  | 12 Hours          | 96 Hours                |
| Final Electrical Test           | 100%  | 25 °C             | -55 °C, +25 °C, +100 °C |
| Final Visual Inspection         | MIL-STD-883F, Method 2009                         | •                 | •                       |

**Encased Mechanical Diagram**



**NOTES**

- 1) Applied torque per M3 screw is not to exceed 6 in-lb  
Non-Threaded: Dia 0.125" (3.18 mm)
- 2) Pins are 0.080" (2.03 mm) dia. with 0.125" (3.18 mm) dia. standoffs.
- 3) All Pins: Material - Copper Alloy  
Finish: Matte Tin over Nickel plate
- 4) Total weight: 18.5 oz (525 g)
- 5) Tolerances: x.xx +/-0.02 in. (x.x +/-0.5 mm)  
x.xxx +/-0.010 in. (x.xx +/-0.25 mm)

**PIN DESIGNATIONS**

| Pin | Name   | Function         |
|-----|--------|------------------|
| 1   | LINE A | AC Line Input A  |
| 2   | LINE B | AC Line Input B  |
| 3   | LINE C | AC Line Input C  |
| 4   | PE GND | Protective Earth |
| 5   | PFC C  | Filter Output C  |
| 6   | PFC B  | Filter Output B  |
| 7   | PFC A  | Filter Output A  |



# MACF-440-3PH-UNV-MP

## Technical Specification

### Ordering Specifications

| Family                      | Input Voltage                  | Phase               | Input Frequency         | Package                  | Thermal Design         | Screening Level                        |
|-----------------------------|--------------------------------|---------------------|-------------------------|--------------------------|------------------------|--|
| MACF                        | 440                            | 3PH                 | UNV                     | MP                       | D                      | S                                      |
| <b>MACF:</b> AC Line Filter | <b>440:</b> 320-528 Vrms (L-L) | <b>3PH:</b> 3-Phase | <b>UNV:</b> 45 - 800 Hz | <b>MP:</b> M-module Peta | <b>D:</b> Non-Threaded | <b>S:</b> S-Grade<br><b>M:</b> M-Grade |

Example: MACF-440-3PH-UNV-MP-D-M

### APPLICATION NOTES

A variety of application notes and technical white papers can be downloaded in pdf format from our [website](#).

### ORDERING INFORMATION

Not all combinations make valid part numbers, please contact SynQor for availability.

### Contact SynQor for further information and to order:

**Phone:** 978-849-0600  
**Toll Free:** 888-567-9596  
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**E-mail:** [power@synqor.com](mailto:power@synqor.com)  
**Web:** [www.synqor.com](http://www.synqor.com)  
**Address:** 155 Swanson Road  
 Boxborough, MA 01719  
 USA

### PATENTS

SynQor holds numerous U.S. patents, one or more of which apply to most of its power conversion products. Any that apply to the product(s) listed in this document are identified by markings on the product(s) or on internal components of the product(s) in accordance with U.S. patent laws. SynQor's patents include the following:

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| 6,896,526 | 6,927,987 | 7,050,309 | 7,765,687 |
| 7,787,261 | 8,149,597 | 8,644,027 |           |

### WARRANTY

SynQor offers a two (2) year limited warranty. Complete warranty information is listed on our website or is available upon request from SynQor.